Abstract No. smit0471

Spectral-Spatial Artifacts in Infrared Synchrotron Microscopy

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Beamline(s): U4IR

Infrared synchrotron radiation (IRSR) microspectroscopy is becoming a popular technique for the molecular analysis of minute or heterogeneous samples. These instruments utilize high numerical aperture (NA) Schwarzschild-type reflecting objectives to focus tightly the synchrotron beam on the sample. At long wavelengths (λ > 5 μm), diffraction effects limit the spatial resolution of the measurement and also introduce spatial-spectral artifacts. Current research at beamline U4IR utilizes a Spectra-Tech IRμs microscope with an IRSR source to investigate these effects. The artifacts are found to depend upon the Schwarzschild objective's point spread function (PSF), the wavelength of the probe radiation, the size of the field stops, and the dimensions and geometry of the target sample. Figure 1a shows calculations convolving the PSF of a 32x, 0.65 NA Schwarzschild objective transmitting 6 μm radiation with a 12 μm dia. 'sample' ring of absorbing material. The resulting 2D infrared 'image' shows the presence of material inside the ring where none exists in the 'sample.' This scenario is demonstrated experimentally in Figure 1b by a line profile of a 12 μm hole in an amide-containing photoresist (circles). The artifact bump matches perfectly with calculated data (line). Efforts to reduce or eliminate spectral-spatial artifacts through PSF deconvolution routines are currently underway. It is hoped that these methods will also afford sub-diffraction limit spatial resolution.

Acknowledgments: Research supported by DOE through contract DE-AC02-98CH10886 and by the Laboratory Directed Research and Development Program.

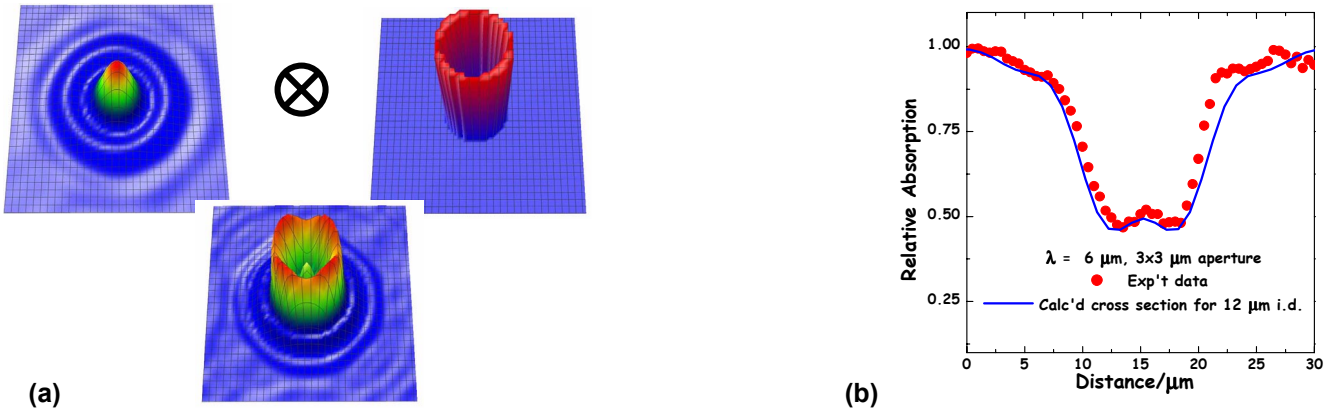

Figure 1. **(a)** A calculated PSF function is convolved with a hypothetical 'sample,' a 12 μm ring of absorbing material, to produce an IRSR 'image' of the sample that bears an artifact bump. **(b)** This effect is demonstrated experimentally by an IRSR profile of a 12 μm hole in an amide-containing photoresist (conditions as indicated). The experimental data (circles) are compared with a calculated profile using the PSF of an idealized Schwarzschild objective (line).